

PREPARATION OF OPERATION AND MAINTENANCE MANUALS

1.0 SCOPE

- 1.1 Scope. This document establishes a standard for content and format to be observed by contractors in the preparation of operation and maintenance manuals for electronic, electrical, and electro- mechanical equipment or systems.
- 1.2 Application. The requirements of this standard shall apply to equipment or systems developed or made to Government specifications. They shall not apply to commercial production items which shall be supplied with commercial manuals, except as specifically identified.
- 1.3 Contracting Officer's Technical Representative. The Contracting Officer's Technical Representative (COTR) shall provide the final interpretation of any conflict between this standard and specific contract requirements.
- 1.4 Waivers. Any request for waiver of specific requirements of this standard shall be submitted in writing to the COTR and to the Contracting Officer. A request for waiver must include: a) identification of the paragraphs for which the waiver is requested; b) identification of the systems, equipment, or components for which the waiver is requested; and c) a discussion of rationale for granting the waiver, including impact on reliability, maintainability, schedule, and cost if the waiver is not granted.

2.0 APPLICABLE DOCUMENTS

- 2.1 Government Documents. The following documents, of the issue in effect on the date of invitation for bid or request for proposal, form a part of this specification to the extent specified herein.

MILITARY

MIL-STD-12C Abbreviations for Use on Drawings,
Specifications, Standards, and in
Technical Documents

MIL-STD-15-1 Graphical Symbols for Electrical
and Electronic Diagrams

MIL-STD-15-3 Electrical Wiring Symbols for
Architectural and Electrical

Layout Drawings

Military specifications and standards are available from: Commanding Officer, U.S. Naval Supply Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

NOAA/NESDIS

Standard No. S24.803 Cable Wire Identification

Standard No. S24.805 Spare Parts

NOAA standards are available from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, OSD/3, Washington, D.C. 20233.

- 2.2 Other Documents. The following publications of the American National Standards Institute (ANSI) form a part of this specification to the extent specified herein.

ANSI-Y14.15 Electrical Diagrams

ANSI-Y32.14 Graphical Symbols for Logic Diagrams

ANSI-Y32.16 Electrical and Electronic Reference Designations

ANSI Standards are available from: American National Standards Institute, Inc., 1430 Broadway, New York City, New York 10018.

3.0 CONTENT

- 3.1 General. The manual shall provide the information necessary to perform installation, test, operation, adjustment, alignment, repair, parts replacement, and calibration. All information shall accurately represent the system, equipment, or function described.

- 3.2 Arrangement. The manual shall include the following major sections in the order given.

- a. Front Matter
- b. Section I - General Description
- c. Section II - Installation
- d. Section III - Theory of Operation
- e. Section IV - Operation
- f. Section V - Maintenance
- g. Section VI - Parts List
- h. Section VII - Drawings
- i. Appendices

If the document is printed on both sides of the page, each major section shall begin on a right-hand page. When a section is of such length as to be unwieldy, it may be subdivided into chapters or parts.

3.3 Major section content. Each section of the manual shall conform, insofar as applicable, to the requirements listed herein.

3.3.1 Front matter. The front matter shall include:

- a. Title page
- b. English/metric conversion factors
- c. Contractor's warranty statement (optional)
- d. Cautionary notes, if applicable
- e. Table of contents
- f. List of illustrations
- g. List of tables
- h. Glossary of terms, abbreviations, and acronyms
- i. Frontispiece (optional)

3.3.2 General description. The general description shall contain the following information in the order listed.

3.3.2.1 Equipment illustration. This picture, usually designated as Figure 1-1, shall be a composite illustration of the total equipment or system. It shall give the names and designations of the major components, if applicable. This figure may be omitted if the frontispiece satisfies the requirement.

3.3.2.2 Introduction. The introduction shall provide a brief statement of the purpose of the equipment, how that purpose is accomplished, and equipment limitations.

3.3.2.3 Physical description. The physical description of the equipment shall include the following:

- a. A tabulation of the major components, giving name, location, reference designation, and reference to an identifying illustration. (Components are construed to mean plug-in modules, sub-chassis, chassis, rack, cabinet, etc.) If the equipment is relatively simple and comprises not more than two components, this tabulation may be omitted.
- b. Illustrations, photographs, or drawings for identification of each major component. Front or front oblique views are preferable. Rear views shall also be provided if there are rear surface connections or adjustments. If the equipment is comprised of only a few components and such illustrations would duplicate the frontispiece or Figure 1-1, they may be omitted.
- c. Brief descriptive text covering the salient physical features of the equipment. Items to be included, for example, are type of construction, size, shape, weight, type of connectors,

and use of modular components.

- 3.3.2.4 Functional description. The functional description shall provide a brief account of what the equipment does, how it operates, and the way each major function section contributes to total performance. An overall block diagram of the equipment shall be included as part of the functional description.
- 3.3.2.5 Salient characteristics. Salient characteristics of the equipment, condensed and tabulated where practicable, shall include at least the following:
- a. Electronic semiconductor, integrated circuit, and indicator lamp components, including location, reference designation, quantity used, type, and function of each.
 - b. Circuit board listing, giving name location, reference designations, quantity used, type, and function of each.
 - c. Primary power requirements, with allowable variations from nominal values, given in volts, amperes, and for alternating current, frequency range, and phases for each separately housed or powered component of the equipment.
 - d. Brief summary of the electrical and mechanical performance characteristics with listings of values and tolerances of input and output signal parameters.
 - e. Environmental limitations of the equipment, including any unusual requirements such as susceptibility to electromagnetic radiation or need for special cooling or ventilation.
 - f. Operational hazards to personnel and precautions to be observed.
 - g. Test equipment and special tools required for installation, adjustment, calibration, test, and maintenance.
 - h. Any equipment or items required but not supplied.
- 3.3.3 Installation. This section shall describe and illustrate the work necessary to install the equipment and make it completely operable. The listed information, as applicable, shall be provided.
- 3.3.3.1 Unpacking. Any special precautions to be observed during unpacking of the equipment shall be given. If special supports, brackets, retainers, or stops are installed for shipping, instructions for their removal or release shall be included.
- 3.3.3.2 Assembly and mounting. Complete instructions for assembly of the various components of the equipment and their mounting into racks, cabinets, or other enclosures, if applicable.

- 3.3.3.3 Cabling and wiring. Information shall be provided for any interconnecting cabling or wiring required. Included shall be:
- a. Complete fabrication instructions for all cables which must be made up from bulk supplies, such as wire, coaxial cables, terminals, and connectors.
 - b. A cable list to identify cables and their connection points. Cable numbers shall be included. The connections of individual wires in a multiconductor cable may be given by reference to the appropriate cable and wiring diagrams.
- 3.3.3.4 Initial test and adjustment. Procedures shall be provided for testing and adjusting the equipment after installation to ensure it is completely operable and meets all performance specifications amenable to testing in the field. Only those procedures unique to initial equipment checkout should be included.
- 3.3.4 Theory of operation. This section shall contain at least the information specified below, and any additional information necessary to a complete understanding of the equipment's theory of operation.
- 3.3.4.1 Technical level. The information shall be presented from the standpoint of a technician having a good general background of education and experience in electronics, but not necessarily in equipment similar or related to that covered in the manual. Unusual circuits or new circuit arrangements shall be clearly and fully explained, normally with the aid of simplified schematics. Elementary theory normally found in basic textbooks shall normally be excluded. However, even elementary theory shall be included for those circuits and devices new or recent in the state of the art. The emphasis throughout the section shall be on how the equipment works, rather than on design considerations.
- Where necessary for a complete understanding, the discussion shall be in specific, quantitative terms, but the use of mathematics on a design engineering level shall be avoided wherever possible.
- 3.3.4.2 Organization. The organization of the section, or each part of the section, shall include four levels of discussions, or as many of the four as applicable.
- 3.3.4.2.1 System level. The first, or system, level of discussion shall be on the complete system, keyed to an overall block diagram, with the individual blocks generally corresponding to the individual physical or functional units of the system (e.g., a chassis or subsystem such as the receiver portion of a radar set).
- 3.3.4.2.2 Functional unit level. The second, or functional unit, level shall discuss each physical or functional unit, keyed to block diagrams, with the individual blocks in the diagrams generally corresponding to the individual circuits in the unit (e.g., power supply, IF strip, phaselock detector).

- 3.3.4.2.3 Circuit level. The third, or circuit, level shall discuss the circuits, keyed to block diagrams, the diagrams generally corresponding to the individual stages in the circuit. An explanation of logic symbols used shall be provided for logic circuitry.
- 3.3.4.2.4 Stage level. The fourth, or stage, level shall discuss individual stages, keyed to simplified and/or complete schematics.
- 3.3.4.3 Block diagrams and simplified schematics. Block and simplified schematic diagrams shall be provided as necessary to explain the theory of operation. Diagrams shall be arranged in logical sequence to facilitate signal tracing between chassis, modules, circuits, cards, etc. They shall show, as applicable, the following information:
- a. Input and output signals by name and approximate waveshape.
 - b. Time, amplitude, and phase relationship of significant waveforms.
 - c. Control signal voltage levels and frequencies.
 - d. Reference designations of input and output terminals or connectors.
 - e. Stage names and the reference designations of the major stage components, such as semiconductors, integrated circuits, etc..
 - f. The reference designations of detail components. (Component values should not be shown unless necessary for understanding circuit operation.)
- 3.3.4.4 Mechanical components. The theory of operation of mechanical components or devices whose complexity or relative unfamiliarity so warrants shall be described. However, construction details and mechanical theory shall normally be subordinated to the components's overall purpose and relationship to the electronic or electrical components.
- 3.3.5 Operation. This section shall provide complete and explicit instructions for operating the equipment for: a) the first time, b) under normal conditions, c) under emergency conditions, such as a partial mechanical or electrical failure, and d) in each available mode (e.g., automatic, semi-automatic, and manual). The following information shall be given:
- a. A tabulation of all operating controls, adjustments, and indicators giving name, reference designation, brief statement of function, and reference to the illustration where the control, adjustment, or indicator is shown.
 - b. Illustrations showing and calling out the name and reference designation of each operating control, adjustment, and indicator.

- c. Separate step-by-step initial turn-on, normal operating, and emergency operating procedures. Instructions for checks, calibration, and adjustment required as part of operation shall be given as part of these procedures.
- d. If the equipment employs patching, text and illustrations shall be provided to describe the patching arrangements to be used.

3.3.6 Maintenance. The maintenance section of the manual shall provide the information specified below, as applicable.

3.3.6.1 Preventive maintenance. Preventive maintenance procedures shall include the following items:

- a. An inspection schedule, preferably in tabular or chart form, listing all parts requiring inspection, time periods for inspection performance, and conditions to observe.
- b. A lubrication schedule, preferable in tabular or chart form, giving all points requiring lubrication, time periods for lubrication, the specific lubricant required, and the method of application.
- c. A cleaning schedule, preferably in tabular or chart form, listing all areas requiring periodic cleaning, time periods for cleaning, specific cleansers or methods to be used, and any precaution to be observed.
- d. A schedule for periodic adjustments and replacement of expendable parts, listing and describing adjustments with their tolerances and expendable parts with expected life.
- e. Any special or unusual instructions or procedures required to keep the equipment within specified operational tolerances.

Lubricants and specific cleansers, or their substitutes, shall be listed by Federal or Military Specification, or Federal Stock Number, if applicable.

3.3.6.2 Corrective maintenance. Corrective maintenance information shall include the following items:

- 3.3.6.2.1 Minimum performance standards. These standards shall outline in chart or tabular form the indications, readings, and tests indicating to maintenance personnel the equipment will provide at least minimum acceptable results. These observations shall be obtained from indications of significant equipment characteristics or functions. For complex equipment or systems, two or more minimum performance standards may be necessary -- total system level, and subsystem or component levels.
- 3.3.6.2.2 Test and adjustment procedures. These procedures shall provide, in concise, fully detailed, step-by-step form, all instructions (except those provided elsewhere in the manual) necessary for

testing, checking, tuning, alignment, adjustment, and calibration of each physical or functional unit of the equipment. Illustrations or diagrams shall be provided to show points and methods of connections between equipment components and test equipment.

3.3.6.2.3 Repair and replacement procedures. These procedures shall provide all special instructions necessary for repair and replacement of defective electrical and mechanical parts, assemblies, and units. Associated disassembly, assembly, and adjustment procedures given in detail elsewhere in the manual may be included in the repair and replacement procedures by reference. In addition to required step-by-step procedures, information of the following types shall be provided, as applicable, for determining when parts are satisfactory for continued service or should be repaired or replaced:

- a. Spring force, compression or tension, measured in grams or ounces.
- b. Pressure between contacts when closed.
- c. Clearance between contacts when opened.
- d. Allowable wear and correct pressure for brushes in rotating machinery.
- e. Limits to which commutators may be turned and depth of insulation undercut.
- f. Allowable end play, backlash, tolerances, and clearances for mechanical assemblies and gears.
- g. Tape tension on magnetic tape drives, and disc drive head clearances.

3.3.6.2.4 Disassembly and assembly procedures. These procedures shall provide fully detailed step-by-step instructions for the disassembly of all repairable assemblies and units, where the method is not obvious by inspection. This is intended primarily for mechanical items rather than electronic components unless special techniques are required. Disassembly shall include or reference illustrations or drawings to identify parts and show sequence of operations. Exploded or sectional views shall be provided, as necessary.

3.3.6.2.5 Troubleshooting information. This information shall describe the general procedure to be followed in locating malfunctions and describe in detail any specific procedures or techniques necessary or helpful in locating particular types of malfunctions or any malfunctions in unusually complex or intricate circuits or equipment. Troubleshooting tables, charts, or diagrams may be employed to present specific procedures but are not desired unless they provide information which would not be obvious to a technician familiar with the equipment and unless they provide information not presented in the minimum performance standards, maintenance data, or elsewhere in the manual.

- 3.3.6.2.6 Diagnostic routines. Diagnostic software shall be provided for all computer and computer peripherals included. Supplied software shall exercise the entire instruction set and all functions of all central processor and peripheral equipment, including memory and all external device interfaces. Routines shall check for anomalous operation and notify the operator of normal or erroneous results in a manner that will assist in diagnosis and repair of equipment malfunction.

Diagnostic routines shall be supplied on EAM cards, punched paper tape, magnetic tape or disc packs, as appropriate for loading from the normal program-load peripheral and for loading from at least one alternate I/O device.

Diagnostic routines shall be fully documented, including listings, diagnostic functions, operating instructions, sample printouts, and results, etc. Review of the diagnostic routines shall be included as part of the manual review required herein.

- 3.3.6.3 Maintenance data. Maintenance data shall include the following as applicable.

- 3.3.6.3.1 Terminal voltages. This data, preferably in tabular or chart form, shall show voltages, AC and DC supply and signal, to be expected under normal conditions at significant points of the equipment circuitry. Allowable variations from nominal values, type of meter or instrument to be used, and conditions of test shall be specified. Suggested locations for measurement are:

- a. Transistor sockets or pins
- b. Integrated Circuit sockets or pins
- c. Connector pins
- d. Transformer terminals
- e. Module terminals
- f. Circuit card terminals
- g. Circuit card test points
- h. Any significant circuit junctions not identified above

- 3.3.6.3.2 Terminal resistances. This data, preferably in tabular or chart form, shall show the normal DC resistance from point-to-point or point-to-signal ground or chassis ground at all significant points of the equipment circuitry. Allowable variations from nominal values and conditions of test shall be specified. In small-signal semiconductor circuits where connection of an ohmmeter might damage circuit components, resistance measurements shall be prohibited or presented with cautions or notes on special techniques (e.g., remove transistors from sockets) as appropriate. Suggested locations for measurements are:

- a. Transistor or integrated circuit socket pins
- b. Transformer terminals
- c. Module terminals
- d. Circuit card terminals

- e. Network terminals
- f. Any significant circuit junction not identified above

3.6.3.3 Pulse shape charts. These shall clearly indicate all essential characteristics of every significant pulse shape in the equipment. Typical characteristics to be indicated are:

- a. Polarity
- b. Leading edge amplitude
- c. Width
- d. Rise time
- e. Overshoot
- f. Droop or tilt
- g. Fall time
- h. Undershoot
- i. Trailing edge amplitude
- j. Ripple or ringing
- k. Pulse spacing

Each pulse shall be identified as to where in the circuitry it is to be observed and how the oscilloscope is to be set (sweep speed, vertical sensitivity, etc.).

3.3.6.3.4 Timing diagrams. These diagrams shall illustrate the timing relationships of pulse circuits, relays, electromechanical actions, etc., wherever timing relationships are essential to a complete understanding of equipment functions.

3.3.6.3.5 Other data. Any other data required or useful for equipment maintenance shall be included in the manual in the most usable form. For example: manufacturer's specifications on unusual components or encapsulated items, computer communications interface standards, protocol, and formats; annotated firmware and software listings.

3.3.6.4 Recommended test equipment. The manual shall include a list of recommended test equipment giving manufacturer and model for each item, and necessary salient performance features.

3.3.6.5 Special tools and test equipment. A list of any special tools or test equipment required to maintain the equipment shall be supplied giving manufacturer and model or part number. Details of their use, if not obvious, shall be described.

3.3.7 Parts List. A tabulation of replaceable parts, components, and assemblies shall be prepared in accordance with Standard No. S24.805, "Spare Parts," and included in the manual.

3.3.7.1 Tables of parts. A parts table shall be provided for each chassis, assembly, circuit card, etc., of the equipment. If multi-level tables are required, each table shall list component assemblies which are further

broken down and, conversely, each table shall designate the next higher assembly.

- 3.3.7.2 Parts tables index. A list of parts tables shall be provided. This index shall give table number, title of assembly, and page number on which the table appears.
- 3.3.7.3 Parts identification. Parts shall be identified, in addition to any other description, by their reference number on the drawing or schematic where it appears (for example, R301).
- 3.3.8 Drawings. This section shall include drawings, diagrams, and associated information necessary to the understanding of the functioning and physical configuration of the equipment. All drawings shall be legible, and in the case of those reduced to fit into the manual, readable without a magnifier. Professional drafting techniques shall be used; rough drafts or hand drawn sketches are not acceptable in final manuals. Symbols and legends used on drawings shall conform to the requirements of the documents listed in Section 2.0 of this standard.
 - 3.3.8.1 Drawing index. An index of all drawings included in the manual shall be provided in the front of the section. It shall provide a cross reference between drawing numbers and figure number as well as page number information.

4.0 FORMAT

- 4.1 Style. Manual text and illustrations shall be factual, specific, concise, and clearly worded. They shall provide operating and maintenance personnel with all information required for installation, test, repair, adjustment, and calibration of the equipment. Sentence form shall be simple and direct, avoiding obvious and nonessential theoretical discussions. Emphasis shall be on description of the equipment and specific procedures for operation and maintenance.
 - 4.1.1 Person and mood. The second person imperative shall be used for operation procedures -- for example: "Connect the oscilloscope probe to test point J208." The third person indicative shall be used for description and discussion--for example; "The primary spacecraft command channel is at S-band."
 - 4.1.2 Consistency. Nomenclature shall be consistent throughout the manual. The same name shall be used for the same item everywhere, including the parts lists.
 - 4.1.3 Abbreviations. Abbreviations shall be held to a minimum. Those used shall be in accordance with MIL-STD-12.
 - 4.1.4 Notes, cautions, and warnings. Notes, cautions, and warnings adjuncts to the text, shall be used as defined below. Their use should be limited to cases of real need and designed to be obvious in the text.
 - a. Note -- An operating procedure, condition, etc., essential to highlight.

- b. Caution -- An operating procedure, practice, etc., which might result in personal injury if not correctly followed.
 - c. Warning -- An operating procedure, practice, etc., which might result in personal injury or loss of life if not correctly followed.
- 4.1.5 Tables. Material best presented in tabular form shall be organized into a formal table, and given a title and number.
- 4.2 Layout. The manual text, illustrations, and tables shall be arranged for clarity and ease of use.
- 4.2.1 Typography. While typeset text is preferable, it is not economical for small quantities of a manual. Clean, 600 dpi laser printer copy is acceptable, preferably of a bold Times New Roman Regular 12 pt. typeface.
- 4.2.2 Page size and arrangement. The manual shall be printed on pages 8-1/2 x 11 inches (except where larger sheets are required for drawings). Pages may be printed on both sides.
- 4.2.3 Figure and table titles. All figures and tables shall be identified by descriptive titles. Only first and important title words require capitalization. Except on foldout pages, figure titles shall be centered below the corresponding table. On foldout pages, titles shall be in the lower right corner.
- 4.3 Paper. The manual shall be printed in black ink on white paper as specified below.
- 4.3.1 Text. If the manual is printed only on one side of the page, either 120 lb. white offset or 40 lb. #1 white miniobond paper shall be used. (Beware "Xerox" machines will not normally handle (feed) paper above 20#/24#). Manuals printed on both sides of the page shall use the 120 lb. offset due to its greater opaqueness.
- 4.3.2 Drawings. Drawings, schematic diagrams, block diagrams, or other such pages requiring folding or heavy usage shall be printed on 48 lb. #1 white miniobond or equivalent paper. Foldout drawings shall be standard "B" size unless otherwise indicated. The contractor shall provide a full size "E" drawing and each drawing in either AutoCAD V.14 or greater or VISIO on a electronic media (CD, diskette, special tape).
- 4.4 Binders. Each manual shall be assembled into an appropriate binder. Small manuals (20 sheets or less) may be in flexible or lightweight binders, while the thicker ones should be in heavier binders. In general, there are three acceptable types of binders:
- a. Pressboard binders assembled with a metal prong fastener and compressor, suitable for manuals up to one-half inch thick.

- b. Plastic 19-ring binders (General Binding Corporation, or equivalent), suitable for manuals up to 1-inch thick.

4.4.1 Front cover printing. The front cover shall bear at least the following information:

- a. Name of the equipment the manual describes
- b. Name and address of the contractor
- c. Number of volume if manual is in multiple volumes.

It is permissible (except for metal ring binders) to use a "window" cover to display a portion of the title page to fulfill the above requirements.

4.4.2 Backbone (spline) printing. The manual title, or a significant portion thereof, shall be printed on the binder backbone (spline) if it is at least 5/16" wide.

4.5 Title page. The manual shall have a title page bearing the following information: (Figure 1, "Sample Title Page").

OPERATION AND MAINTENANCE MANUAL

FOR

S BAND ANTENNA SYSTEM

MODEL OSD3

PREPARED FOR

U. S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE

CONTRACT NO. NA-50-DGNE-XXXXX

**ASTRONOMICAL ANTENNA CORPORATION
301 SPACE DRIVE
RUSSEL, KANSAS 76380-6459**

NOVEMBER, 1998

Figure 1 - "Sample Title Page"

- 4.5.1 Title. The manual title shall consist of the words "Operation and Maintenance Manual for" followed by the name and model number of the equipment.
- 4.5.2 Authority statement. This shall consist of the statement, "Prepared for the U.S. Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data and Information Service (NEDSIS).
- 4.5.3 Contract number. This shall be the contract number under which the equipment is procured.
- 4.5.4 Contractor. This shall give the contractor's name and address in full and telephone number, including area code.
- 4.5.5 Date. This shall give the publication date, month and year, of the manual.
- 4.6 Table of contents. The table of contents shall list the number and title of each section, chapter (if applicable), and primary paragraph heading and page number on which it begins. In multi-volume manuals, each volume shall contain a table of contents covering all volumes.
- 4.7 List of illustrations. The list of illustrations shall contain the number, title, and page number of each illustration in the manual. Listing shall be in consecutive order of the illustration numbers.
- 4.8 List of tables. The list of tables shall contain the number, title and page number of each table in the manual. Listing shall be in consecutive order of table numbers.
- 4.9 Numbering. To facilitate use of the manual, its elements shall be numbered as listed below.
 - 4.9.1 Sections. Sections, as defined in paragraph 3.2, shall be numbered consecutively in roman numerals.

- 4.9.2 Appendices. Appendices shall be consecutively ordered alphabetically (Appendix A, Appendix B, etc.).
- 4.9.3 Text pages. Beginning with the first page (a right-hand page if manual is printed on both sides) of Section I (as page 1-1), all pages in each section shall be numbered consecutively using arabic numerals. The numeral preceding the dash shall indicate the section (converted from roman to arabic and the number following the dash shall indicate the page within the section.
- 4.9.3.1 Front matter. These pages, preceding Section I shall be numbered consecutively with lower case roman numerals (i, ii, etc.). The table of contents shall begin on page i. The title page, english/metric conversion factors, warranty statement, and cautionary statement shall not be numbered.
- 4.9.3.2 Foldout and blank sheets. If the manual is printed on both sides, foldout and other sheets with blank backs shall be assigned two page numbers. Both numbers shall appear on the face side (example 7-1/7-2).
- 4.9.3.3 Appendix pages. Appendix pages shall be consecutively numbered in each appendix (A-1, A-2, etc.).
- 4.9.4 Paragraphs. Paragraphs shall be numbered consecutively in each section using arabic numerals. The first numeral shall denote the section; succeeding numerals shall indicate the consecutive order within the section (for example, 3.1, 3.1.1, 3.2, 3.2.1, etc.). Paragraphs in appendices shall be designated A.1, A.1.1, etc.
- 4.9.5 Procedural steps. Procedural steps within a paragraph may be assigned consecutive lower case letters of the alphabet for clarity. The same procedure is desirable in other listings forming a part of the text.
- 4.9.6 Illustrations. Illustrations shall be numbered consecutively within each section in the order of their appearance. The number shall consist of two arabic numerals separated by a dash. The numeral preceding denotes the section, while the succeeding one denotes the order within the section. For example, Figure 3-1 designates the first illustration in Section III.
- 4.9.7 Tables. Tables shall be numbered consecutively within each section in the order of their appearance. The number shall consist of two arabic numerals separated by a dash. The numeral preceding the dash denotes the section, while the succeeding one denotes the order within the section. For example, Table 5-2 designates the second table in Section V.
- 4.10 Quantities. The contractor shall deliver six (6) final copies per site of each original, custom manual developed, as described herein. (Training or test requirements may necessitate the delivery of greater quantities, particularly of draft versions.)

5.0 QUALITY ASSURANCE PROVISIONS

- 5.1 Manual review. Reviews of the manual shall be held as required during its preparation to assure compliance with this standard and provide a document of maximum usefulness. Manual reviews will be conducted at contractor's facility or a Government site as mutually agreed.
- 5.2 Draft manual. A draft of the manual shall be prepared and submitted to the COTR for review prior to production of the final manual. If a training program is part of the contract requiring the manuals, draft copies of the manual shall be used as a text to support the instruction.
- 5.3 Final manual. The final manual shall be prepared after approval of a final draft. The final draft shall incorporate the corrections derived from the training program as well as other items requested by the COTR.
- 5.4 Machine Readable Copy. A single copy of all text, tables, and illustrations generated on word processing equipment shall be provided in Wordperfect V10.0 or equivalent on 3.5 inch IBM-PC compatible floppy disks or CD ROM. Each disk/CD shall be labeled as to contents, consistent with Section 4.6, and indicate the machine of origin and generating word processing package. Text shall be readable (importable) by WordPerfect. Contract drawings shall be in AutoCAD V14 or VISIO format.

6.0 COMMERCIAL EQUIPMENT MANUALS

Documentation and manuals shall be supplied for commercial off-the-shelf equipment (COTS), as available from the OEM. Manuals shall be provided for operations and maintenance, systems interfaces, software/firmware and hardware maintenance of COTS/OEM equipment. Hardware maintenance manuals should be provided if available from the supplier. COTS documentation shall have equivalent content, print quality, and binding to the requirements of this standard including electronic requirements of paragraph 5.4 above. Revisions and change orders issued by the OEM up to the time of delivery of the equipment or system to the Government shall be incorporated in and bound with the applicable manual(s).

Documentation provided by a COTS equipment supplier shall be provided in electronic form. If not offered by the COTS supplier, the contractor shall manually scan the document into an electronic format of the other documentation delivered. Scanned documentation may be provided in read-only form.

Manuals shall be provided to the government using the following guidelines:

- 1. Manuals used operationally or frequently for operator/user instruction, and manuals needed for maintenance and repair (including test equipment documentation) shall be provided at five (5) copies of each per site.
- 2. Manuals which are non-operational, reference sources (e.g. those which "would be nice to have" to answer esoteric questions regarding the equipment) shall be provided at three (3) copies of each total.

All but two (2) copies of OEM manuals may be delivered in microfiche format (24x or 48x reduction), at the option of the contractor.